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EXAMINER
KIELIN, ERIK J

ART UNIT	PAPER NUMBER
2813	# 5

DATE MAILED: 03/07/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/893,340	Applicant(s) KANG ET AL.	
	Examiner Erik Kielin	Art Unit 2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 January 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *9-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *9-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *26 June 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

1. Fig. 1 is objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "2105" has been used to designate both "a bottom surface" (specification, p. 5, line 28) and a top surface layer.

2. Fig. 1 is objected to as failing to comply with 37 CFR 1.84(p)(4) because reference characters "2107" and "2100" have both been used to designate the silicon wafer.

3. Fig. 1 is objected to as failing to comply with 37 CFR 1.84(p)(4) because reference characters "2101" and "2111" have both been used to designate the material portion to be removed. Note that 2111 should probably be pointing to the cross hatched region which designates that implanted particle region. Compare to Fig. 2.

4. Fig. 1 is objected to as failing to comply with 37 CFR 1.84(p)(5) because it does not include the following reference sign(s) mentioned in the description: 2103.

5. Fig. 5 is objected to as failing to comply with 37 CFR 1.84(p)(5) because it includes the following reference sign(s) not mentioned in the description: 2600.

6. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "plurality of structures" (as recited in instant claims 23 and 27), the "plurality of transistors" (instant claims 23 and 27), the "transistor-related structure" (instant claim 24) must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

7. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

8. The disclosure is objected to because of the following informalities:

on p. 11, line 13, replace ".." with a single period, for grammatical correctness;

on p. 11, line 28, replace "purposes" with -- processes-- for clarity; and

on p. 12, ; 5, replace "Fig. 16" with --Fig. 5-- for consistency with the figures.

Appropriate correction is required.

9. Claims 9-18 is objected to because of the following informalities:

in claim 9, line 6, remove "is" for clarity.

Appropriate correction is required.

The remaining claims are objected to for depending from claim 9.

Claim Rejections - 35 USC § 112

10. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

11. Claims 9-18, 20, 23-24, and 27-28 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to

reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Regarding claims 9 and 20, Applicant's entire disclosure provides no antecedent basis for the surface range reduction of "at least about *thirty* percent or more" as presently required in claims 9 and 20. (Emphasis added.) The disclosure, including the claims originally filed in parent applications 09/399,985 and provisional application 60/130,423, provides support only for a reduction in the surface roughness by at least about 50 percent or more, and for reductions up to 80 to 90 percent. (See Abstract; p. 3, lines 8-14.)

12. Claim17 also introduces new matter as follows: the limitation "wherein said environment is said surface." There does not appear to be support for this limitation in the original disclosure.

Regarding claims 23 and 27, the original disclosure teaches forming neither a "plurality of structures" nor a "plurality of transistors" on an epitaxially grown silicon layer.

Regarding claims 24 and 28, the original disclosure does not teach that the cleaves surface is "free of any transistor-related structures." Rather the specification indicates on p. 12, lines 5-7, that the "finished wafer includes a substantially smooth surface 2601 [Fig. 5], which is generally good enough for the manufacture of integrated circuits without substantial polishing or the like."

13. Claim 17 is rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for an environment having the halogen and hydrogen gas, does not reasonably provide enablement for "wherein said environment is said surface." The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims.

The term "environment" is defined as "the circumstances, objects, or conditions by which one is *surrounded*" or, in broader terms as that which surrounds a person, place, or, in the instant case, a thing. (See Merriam Webster's Collegiate Dictionary, 10th ed., p. 388.) The surface cannot simultaneously be that which surrounds it. Accordingly, one of ordinary skill could not practice the method commensurate in scope with the claim.

14. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

15. Claims 9-18, 24, 27-28 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

16. Claim 9 recites the limitation "said cleaved surface" in line 7. There is insufficient antecedent basis for this limitation in the claim because the term "cleaved" has not been used. Instead, only a surface with a roughness is previously recited in the claim.

The remaining claims are rejected for depending from claim 9.

17. Claim 12 recites the limitation "said HCl gas" in lines 1. There is insufficient antecedent basis for this limitation in the claim. This rejection could be overcome by changing the claim to depend from claim 10 which recites HCl gas, instead of claim 11 from which is presently depends.

18. Claim 15 recites the limitation "cleaved surface" in line 1. There is insufficient antecedent basis for this limitation in the claim because the term "cleaved" has not been used. The rejection could be overcome by replacing the term "cleaved" with --said--.

The claims 10-18 are indefinite or, are further indefinite, for depending from independent claim 9.

19. Regarding claim 24, the claim is indefinite because it is unclear how the cleaved surface can be "free of a transistor related structure **on** said cleaved surface " while at the same time the "transistor-related structure ... is provided **on** said cleaved surface." (Emphasis added.) Either the cleaved surface has transistors or it does not; it cannot be both.

20. Regarding claim 27, the phrase "a plurality of structures **may be** formed" (emphasis added) is vague and indefinite for failing to positively recite the process steps. It is unclear whether or not the structures are, or are not, formed.

Claim 28 is indefinite for depending from claim 27.

For the remainder of the action, the claims will be interpreted as best understood by Examiner.

Claim Rejections - 35 USC § 103

21. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

22. Claims **19**-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,251,754 B1 (**Ohshima** et al.) in view of the article **Moriceau** et al. "Hydrogen annealing treatment used to obtain high quality SOI surfaces" IEEE International SOI Conference, October 1998, pp. 37-38.

Ohshima discloses a method a manufacturing an SOI substrate on which semiconductor devices are to be formed, comprising,

forming a cleaved surface (called "detached surface" at col. 11, lines 36-56);

high temperature annealing the cleaved surface to remove surface roughness (called "flattening the surface") created by the cleaving process (Fig. 3, step P15; Fig. 4D-4E; col. 11, lines 50-56).

Ohshima does not specify the conditions of the high temperature anneal.

Moriceau discloses exposing a rough silicon surface to an etchant --which is specifically hydrogen (as further limited in instant claim 21)-- while annealing at a temperature of greater than 1000 °C to reduce the silicon surface roughness from about 50 Å to a few Å, which equates to about a 90% reduction surface roughness (assuming a few to be about 5 Å, implying, 5 Å/50 Å times 100 = 90%). (See whole document -- especially third paragraph and Fig. 1.)

Note also that **Moriceau** also teaches that any native oxide is also removed by this etchant anneal, at the second sentence of the fourth paragraph, which is also a desired result of the **Ohshima** high temperature anneal (col. 11, line 55).

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use the roughness-reducing, hydrogen-etchant anneal of **Moriceau** as the high temperature anneal of **Ohshima**, because **Ohshima** desires a native-oxide-removing, surface-flattening anneal to prepare the cleaved silicon surface for growth of an epitaxial layer, and because **Moriceau** provides the successful anneal conditions to provide such desired results.

23. Claims **19**, 21, 22, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of US 5,141,878 (**Benton** et al.).

Ohshima is applied as above.

Ohshima does not teach the conditions of the anneal.

Benton teaches the benefits of doing a pre-bake anneal of a rough silicon surface in an HCl-H_2 mixture at a temperature of greater than 1000 °C, to "reduce native oxide films and to further smooth" the silicon wafer (col. 2, lines 45-53).

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use the roughness-reducing, HCl-H_2 etchant anneal of **Benton** as the high temperature anneal of **Ohshima**, because **Ohshima** desires a native-oxide-removing, surface-flattening anneal to prepare the cleaved silicon surface for growth of an epitaxial layer, and because **Benton** provides the successful anneal conditions to provide such desired results.

Regarding claim 25, **Ohshima** does not specify the gas mixture used during the epitaxial growth of the silicon layer.

Benton further teaches using a gas mixture containing the etchant mixture HCl-H_2 along with a silicon-atom precursor gas, SiH_2Cl_2, to grow the epitaxial silicon layer. Note also that SiH_2Cl_2 also decomposes to form, *inter alia*, HCl, Cl_2, and H_2 during the epitaxial growth of the Si, which provides further etchant gas. (See col. 2, lines 54-59.) Note in this regard that Applicant's specification indicates that the etchant anneal can be carried out at 900 °C to about 1000 °C. (See instant specification, p. 3, lines 11-12.) Accordingly, the HCl-H_2 mixture necessarily etches the silicon surface during the epitaxial growth.

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use the epitaxial growth mixture of **Benton** in the method of **Ohshima** because **Ohshima** grows an epitaxial Si layer, but does not specify the growth mixture, and one of ordinary skill would be motivated to use any art known growth mixture such as the one taught in **Benton**.

24. Claims 23, 24, and **27**-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of **Benton** as applied to claim19 above, and further in view of Applicant's admitted prior art (**APA**).

The prior art of **Ohshima** in view of **Benton**, as explained above, discloses each of the claimed features except for indicating that the transistor or transistor structures are formed on the substrate. Both **Ohshima** and **Benton** teach device formation on the substrate. (Ohshima teaches device formation (col. 1, lines 16-19) and circuit formation (col. 12, lines 60-64). **Benton** teaches a plurality of structures including a photodiode 22 in the epi-Si layer as well as transistors 20 and 21 (Figs. 2E and 3).

Notwithstanding the absence of support in the original disclosure for the limitations of the plurality of structures or plurality of transistor-related structures, **APA** teaches that it is known in the art to form integrated circuits comprising millions of transistors on silicon substrates (specification, p. 1, lines 18-20) and that SOI substrates, in particular, provide better isolation for integrated circuit devices than bulk silicon (p. 2, lines 1-2 and 13-14). Applicant also provides a citation to a well-known textbook for the further processing of the substrates to form the integrated circuits (instant specification, p. 12, lines 25-28).

It would be obvious for one of ordinary skill in the art, at the time of the invention, to form a plurality of transistors on the SOI substrate of **Ohshima**, because **Ohshima** indicates that a circuit is formed on the SOI substrate and because the **APA** teaches that it is known to form integrated circuits with a plurality of transistors on SOI substrates and that such process steps are known.

25. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over either of **Ohshima** in view of **Moriceau,** or **Ohshima** in view of **Benton**, each as applied to claim 19 above, and further in view of US 6,342,436 B1 (**Takizawa**).

Ohshima in view of **Moriceau** or **Ohshima** in view of **Benton** are applied as above.

Neither of **Ohshima** in view of **Moriceau** and **Ohshima** in view of **Benton** teaches the limitation of treating the cleaved surface to increase the hydrogen concentration level prior to the annealing in the claimed gases at a temperature greater than about 1000 °C.

Takizawa teaches a increasing the hydrogen concentration ("pre-annealing") of a silicon surface in hydrogen at 850 °C for 30 minutes prior to an etchant anneal at greater than 1000 °C (specifically at 1150 °C) in either hydrogen etchant alone or hydrogen plus HCl (col. 4, lines 49-53) both of which precede the epitaxial growth. (See especially the cover figure and col. 4, lines 44-57 and col. 6, lines 43-55.)

It would be obvious for one of ordinary skill in the art, at the time of the invention, to modify either of the methods of **Ohshima** in view of **Moriceau** and **Ohshima** in view of **Benton** to "treat the cleaved surface to increase the hydrogen concentration level prior to increasing said temperature of said environment to about 1000 °C or greater," as taught in **Takizawa**, to

beneficially reduce the formation of "bright spots" in the epitaxially grown silicon layer which would otherwise occur if such increase in the hydrogen concentration prior to the anneal at greater than 1000 °C were not carried out. (See **Takizawa** col. 6, lines 21-24.)

26. Claims **9**-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of **Moriceau** and further in view of **Benton**.

Regarding claims 9-11, 13, 15, and 16, the prior art of **Ohshima** in view of **Moriceau**, as explained above, discloses each of the claimed features except for using both hydrogen and halogen gases during the high temperature anneal.

Benton, as noted above, teaches that HCl plus hydrogen smoothes rough silicon and also removes native oxide in preparation for epitaxial growth.

It would be obvious for one of ordinary skill in the art, at the time of the invention, to add HCl to the etchant gas of **Ohshima** in view of **Moriceau** in order to better prepare the rough, cleaved silicon surface for epitaxial growth, as taught by **Benton**.

Regarding claim 12, **Benton** teaches an exemplary ratio of HCl gas in the hydrogen is 0.9 to 40 or about 1 to 40 which is equivalent to about 0.025 and fall within the claimed range of 0.001 to 30.

Regarding claims 14 and 18, the high-temperature annealing in **Ohshima** is carried out in an epitaxial apparatus, which is a thermal process chamber. (See col. 11, lines 50-52.)

Regarding claim 17, indefiniteness, as noted above, notwithstanding, the environment of the surface is that provided by the hydrogen and HCl.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 4,530,149 (**Jastrzebski** et al.) teaches that HCl can be added to a hydrogen bearing environment as an etching gas **during** the growth of epitaxial silicon for the manufacture of uniform, thin silicon layers on an insulating material (i.e. SOI). (Compare page 12, lines 8-24 of the instant specification with **Jastrzebski**, column 2, line 37 to column 3, line 4.)

US 6,274,464 B2 (**Drobny** et al.) discloses an epitaxial growth process wherein the silicon substrate is annealed in a mixture of hydrogen and HCl at 1050 °C prior to epitaxial growth. (See Fig. 3B and associated text.)

Tate et al. ("Defect Reduction of Bonded SOI Wafers by Post Anneal Process in H_2 Ambient" IEEE International SOI Conference Proceedings, 5-8 October 1998). The article discloses a method for treating a film of material comprising, providing a substrate comprising a cleaved silicon surface with a surface roughness and having hydrogen distributed in the surface region of the cleaved surface; and heat treating the cleaved surface in a hydrogen bearing environment to reduce the surface roughness by about fifty percent or greater. (See whole document -- especially page 141, item 3 and Figure 3.)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Erik Kielin

March 6, 2002